Autonomy Technology Challenges by Titan and Europa Exploration Missions

Dr. David J. Atkinson
Jet Propulsion Laboratory

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Abstract

This paper discusses requirements for **autonomy** technology that arise from the unique attributes of proposed exploration missions to **Titan**, a moon of Saturn, and **Europa**, an ice-encrusted moon of Jupiter. Recently, the Project Design Center at NASA Jet Propulsion Laboratory was the focal point for an intensive study of these missions. The JPL Project Design Center is a facility which allows system-level design of missions, spacecraft, and mission operations systems in a concurrent engineering team environment. Researchers supported by the Autonomy Technology and Operations Program at JPL were invited to participate in the Europa and Titan studies by the study leaders. The proposed Titan mission includes an **"Aerobot"**, a robotically controlled lighter-than-air vehicle. Part of the mission for the Titan Aerobot includes sampling and scientific analysis of surface materials. Some of the significant drivers of autonomy requirements on a Titan mission include the difficulty in selecting sampling sites, the consequences of long round trip light time delays for commanding, and exogenous events such as weather. Autonomous site selection, commanding, science operations, and robust fault detection, isolation and recovery are a few of the mission critical areas that are discussed in the paper. The mission to Europa tentatively includes a communications station on the surface of the ice, a **"cryobot"** which will melt through the ice to the ice/water interface, and a **"hydrobot"** which would free-swim under the water in a scientific search for hydrothermal vents. **Autonomous commanding** and **fault protection** technologies are key requirements of this mission, as well as the ability to conduct a science mission with very limited communication to other spacecraft or Earth. The paper will include a discussion of current technology developments at JPL that may be applicable to these requirements, and identification of missing technology that should be included in R&D program planning.

artificial intelligence